REPORT OF THE CHEMIST.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF CHEMISTRY,
Washington, D. C., October 11, 1919.

SIR: I submit herewith the report of the work of the Bureau of Chemistry for the fiscal year ended June 30, 1919.

Respectfully,

C. L. ALSBERG, *Chief.*

Hon. D. F. HOUSTON,
Secretary of Agriculture.

As last year was a year of readjustment within the bureau to meet the demands for assistance made by the Government's war machine, so this year has been one of return to the normal. During the war so much unusual work was required of the bureau that its momentum was temporarily checked, and it had to be content to keep the regulatory work as nearly as possible up to its prewar level. It could not hope to forge ahead. Since the armistice was signed, the bureau has gradually regained its prewar acceleration, with the result that, though four months of the year were war months, and though the armistice did not by any means halt work for the war agencies or make it possible to recruit the bureau's force up to its normal strength, nevertheless 1,133 recommendations for criminal prosecution and 1,052 for seizure alleging violation of the Food and Drugs Act were sent to the Solicitor—by far the largest total for any one year in the history of the enforcement of the Food and Drugs Act. This is not to be taken to mean that the war has lowered the ethics in this country of the food and drug producing industries as a whole, although it has increased sophistication and misbranding in certain special directions. It merely shows that the bureau's regulatory force is gaining in efficiency as it gains in experience, and that the gradual reorganization of the bureau, the evolution of which has been recorded in its reports from year to year, is bringing results.

While the regulatory force of the bureau, despite the depletion of its personnel, is performing a greater volume of work than ever before, the constructive research work has not yet returned to normal. Partly completed war research problems have had to be rounded out, that the time and effort originally expended upon them might not be wholly lost. Moreover, the lure of high salaries is stronger than ever, so that there has been a heavy drain upon the bureau's force through the passing of men from it into the industries. The totally inadequate salaries offered by the Government have made it impossible to fill suitably the gaps thus created. From July 1, 1917, to June 30, 1919, of the war period, the separations from the service, not including men who entered the military service, have been of the technically trained staff 39 per cent of the prewar strength of the bureau, of the clerical staff 68 per cent, and of the staff of laborers,

mechanics, messengers, and the like, 90 per cent. The total separations from the whole bureau, the so-called "turnover," including men furloughed to enter military service, for the two-year period, has been 72 per cent, and there is no indication that conditions are improving. It is obvious that service in the bureau must be made more attractive, especially in its financial aspects, if such efficiency as the Bureau of Chemistry has been able to achieve in the past is to be maintained.

Nevertheless, the momentum of the bureau's research organization has been sufficient to produce a larger number of publications than ever before. There were issued nine department bulletins, two department circulars, two circulars of the office of the Secretary, and one yearbook article. In addition, the results of more than 75 investigations were made public, and those of more than 25 are now in press. The experimental work upon a number of other investigations has been completed. Thirty-five applications for patents were filed, of which 14 were allowed, 6 disallowed, and 15 are pending.

Naturally the work demanded of the bureau by other branches of the Government has lessened since the armistice; but its volume is still considerable. There is every indication that, inasmuch as the war brought to the attention of other branches of the Government the services the bureau is capable of rendering, such collaborative work will never diminish to the prewar volume. It is essential, therefore, that adequate funds for such collaborative work be provided. Moreover, the growth of the bureau in the last 10 years has been such that the quarters available in Washington have long been inadequate, and if its work is not to be progressively crippled, suitable quarters must be provided.

ENFORCEMENT OF THE FOOD AND DRUGS ACT.

DOMESTIC FOODS AND DRUGS.

One thousand and fifty-two recommendations for seizure and 843 recommendations for criminal prosecution were made to the Department of Justice, through the Office of the Solicitor. Table 1 gives a list of the classes of products on which action was recommended to the Solicitor, and also the distribution of the recommendations among the various types of products.

TABLE 1.—*Recommendations of action on alleged violations of the Food and Drugs Act transmitted to the Solicitor.*

Product.	Criminal actions.	Seizures.	Product.	Criminal actions.	Seizures.
Beverages, extracts, flavors	21	15	Lard and lard substitute	2	.....
Candy	1	.....	Meat and poultry	20	3
Chocolate and cocoa	3	16	Nuts	.....	4
Coffee and tea	2	1	Oil, olive, salad, etc	193	130
Colors, food	8	.....	Oranges	.....	43
Dairy products	141	51	Preservatives	1	.....
Drugs, crude, and pharmaceutical preparations	47	37	Sea foods	19	39
Drugs, remedies	122	513	Sirups	11	1
Eggs and egg substitutes	48	23	Spices and relishes	.....	17
Feeds	306	27	Tomato products	50	44
Flour, grain, alimentary pastes	16	6	Vegetables	9	18
Fruits	19	7	Vinegar	35	9
Gelatin	40	25	Water	15	16
Glycerin	.....	1	Total	1,133	1,052
Jam, jelly, and marmalade	4	6			

Examination of Table 1 shows that action was recommended most frequently against shipments of patent medicines, crude drugs and pharmaceutical preparations; of mineral waters and nonalcoholic beverages; of shell eggs and egg substitutes; of dairy products; of gelatin; of olive oil; of oranges and tomato products; of sea foods; of cacao products; of vinegar; and of stock feeds.

In the patent medicine cases, it was alleged usually that they were misbranded as to therapeutic claims under the Sherley amendment. In the case of the crude drugs and pharmaceuticals it was usually alleged either that they did not comply with the requirements of the United States Pharmacopœia and were not labeled to indicate wherein they differed from the standard of the Pharmacopœia, or else that they were otherwise misbranded or adulterated.

In the mineral water cases it was alleged, as a rule, that they were either polluted or misbranded as to therapeutic claims under the Sherley amendment, or both.

The expansion of the nonalcoholic beverage industry has made necessary a close supervision of this class of products. Among the various kinds of violations alleged the most common are based on the representation by the manufacturer that the products consist in whole or in part of fresh fruit juice, when, in fact, they contain only some organic acid and an artificial flavor. Some of these products were found to contain saccharin substituted in whole or in part for sugar.

The work on shell eggs was in the nature of a follow-up campaign of the action taken in previous years and described in the Report of the Chemist for 1918. The eggs arriving in the market continue to improve in quality. The action against egg substitutes is the outcome of the work inaugurated and described last year.

The investigation of dairy products was designed to continue the supervision of evaporated and whole milk received in interstate or foreign commerce. In addition it was found that the high price of butter stimulated its adulteration with water or salt, or both, so as to lower the fat content. Much attention has been devoted to putting a stop to this practice.

The work upon gelatin was a continuation of that described last year to suppress the sale of glue as edible gelatin.

The olive oil cases were brought in conformity with the campaign inaugurated in 1918 to prevent the adulteration with other edible oils of olive oil, which is still practically unobtainable from Italy, although it can be secured from other Mediterranean countries, notably Spain. In consequence, much Spanish olive oil of excellent quality has been misbranded as Italian oil, a practice which it has been attempted to abolish.

The work upon oranges, necessitated by the disastrous frost of last winter, was designed to prevent the sale of frozen fruit. Frozen oranges should be used for the preparation, near the point of production, of jams and preserves, for which they seem suited if used promptly.

While a number of cases have been made against tomato products, the quality of these products as a whole continues to improve vastly. The adulteration of canned tomatoes with added water is becoming rare, and less tomato pulp made from partially moldy or fermenting stock is being produced. Assistance continues to be rendered by the experts of the bureau to manufacturers through personal visits.

The work upon sea foods was confined largely to the adulteration of oysters and scallops with water, termed "soaking" by the trade, the slack filling of cans with shrimp, and the prevention of the sale to the consumer of stale or tainted canned salmon. The latter project occupied more of the time of the regulatory force of the bureau than any other, since it involved the examination in detail of the vast surplus stores of canned salmon held by the Army before they were permitted to be turned back into the ordinary channels of trade.

The cases upon cacao products dealt principally with the adulteration of cocoa with cacao shells.

The cases upon vinegar were of the usual type. A new method has been developed for the identification of waste apple products vinegar by means of which it is hoped that the traffic in this variety of vinegar may be controlled and forced on to a legitimate basis.

The cases against stock feeds comprised the usual types of adulteration and misbranding reported from time to time in previous years. Much attention was paid to rice mill by-products, especially the adulteration with rice hulls, and data were obtained upon the conditions prevailing in the rice mills of the Pacific coast and upon the use of lime in rice milling. It was also found that, owing to the difference in price between bran and shorts, certain manufacturers were selling finely ground bran as shorts.

Of the 1,019 cases of all kinds reported to the department as terminated in the courts during the year, 258 alleged false and fraudulent labeling of medicines, 22 alleged similar misbranding of veterinary remedies, and 56 alleged adulteration or misbranding of stock feeds. All in all, 3 cases were reported as decided unfavorably to the Government.

Among the cases terminated was the bleached flour case which was pending at Kansas City, Mo. (N. J. 6380). The libel was amended to strike out the allegation to the effect that the flour contains an added deleterious ingredient which might render it injurious, in view of the experimental work of the bureau which did not indicate that the allegation was tenable under the interpretation of the law by the U. S. Supreme Court (N. J. 3398). The claimant then withdrew appearance and answer, and a default decree of condemnation and forfeiture was entered as to the remaining allegations in the libel.

Publication has been made of two judicial decisions of interest, involving interpretation of the law. The U. S. Supreme Court, in a judgment reported in Notice of Judgment 6308, affirmed judgment of the lower courts against Oscar J. Weeks, doing business as O. J. Weeks & Co., in connection with the misbranding of an article labeled "Special Lemon, Lemon Terpene, and Citral." A salesman of the defendant in offering the article for sale represented it as lemon oil, which it was not. The defendant upon appeal insisted that under the statute the question whether an article is misbranded turns entirely upon how it is labeled when it is shipped, regardless of any representations made by a salesman in offering it for sale. The U. S. Supreme Court, however, held that the statute specifies and defines at least two kinds of misbranding, one where the article bears a false or misleading label, the other where it is offered for sale under the distinctive name of another article. The two are quite distinct, a deceptive label being an essential element of one

but not of the other. The court accordingly ruled that testimony respecting the representations of the defendant's traveling salesman was rightly admitted in evidence and submitted to the jury.

The case reported in Notice of Judgment 6362 is one under the Sherley amendment to the Food and Drugs Act, alleging misbranding of "Dr. J. H. McLean's Liver and Kidney Balm." The Court of Appeals of the Eighth Circuit reversed a judgment of conviction in the lower court because of error in the instructions of the court, and a new trial was awarded. In the instructions to the jury on the question of the fraudulent character of the statements made by the defendant regarding the article, the court inadvertently said that "one who makes a false statement not knowing whether it is true or false is as guilty of wrong as the man who makes a false statement knowing it is false." The Court of Appeals held this portion of the charge was erroneous, as it permitted the jury to find that these false statements were fraudulent although the defendant honestly believed them to be true.

Two hundred and two of the cases reported as terminated were instituted by 38 different State and city agencies, either independently of or in cooperation with the Bureau of Chemistry. In 1916 there were but 35 such cases instituted by but four collaborating agencies. This very great increase illustrates the growing interest of State and city officials in the Federal act as a supplement to city and State food and drug laws. A rather unusual form of cooperation is found in the enactment by the State of California of a law forbidding the sale of arsenic-bearing sulphur for use in the production of food products. This followed the publication by the bureau of a report upon the arsenic content of sulphur from different sources.

To supersede Circular 19, Office of the Secretary, Circular 136, Office of the Secretary, "Standards of Purity for Food Products," was issued. The service and regulatory announcements published during the year contained 25 opinions and 250 notices of judgment. The following food inspection decisions were issued:

No. 177. Soda Water Flavors and Soda, Soda Water.

No. 178. Milk and Cream.

No. 179. Amending Regulation 29, Which Relates to Marking the Quantity of Food in Package Form.

No. 180. Colors in Food.

Nos. 177 and 178 are based upon the recommendations of the Joint Committee on Definitions and Standards.

No. 179 changes the exemption of small packages from those containing 2 ounces or less to those containing one-half ounce or less. This was done to prevent, in so far as existing legislation will permit, deception through the slack filling of small packages, such as 5 and 10 cent packages of spices. To protect the consumer more fully than is possible under existing statutes from fraud through the slack filling of packages, or the use of containers deceptive as to the amount of food in them because of their shape or dress, the department has recommended to Congress an amendment to the Food and Drugs Act. Moreover, independently of or in connection with other charges, consideration has been given to more than 1,000 cases alleging that the net weight either was not stated on the package or else was wrongly stated. Also numerous investigations have been undertaken to de-

termine the variation in the quantity of the contents of packages of food as the result of the process of packing, as well as from shrinkage in storage and transportation. Such investigations are necessary for the effective enforcement of the net weight amendment.

A very extensive investigation, conducted through two seasons in various sections of the country, to determine the proper fill of cans of fruits and vegetables was carried to a successful conclusion. Based upon the results of this work, announcements of weights which are representative of properly filled cans have been made in the case of peas, unpitted cherries, wax and refugee beans, and peaches.

Food Inspection Decision 180 removed from the list of permitted colors certain ones which had been found unsuitable.

The number of pounds of straight dyes for which certification was asked during the year is as follows: Amaranth, 36,753; Butter Yellow, 3,802; Butter Yellow AB, 333; Erythrosine, 732; Indigo Disulfo Acid, 1,317; Light Green SF Yellowish, none; Naphthol Yellow S, 905; Orange I, 17,142; Ponceau 3 R, 11.832; Sudan I, 2,041; Tartrazine, 38,295. Certification was also asked for 4,750 pounds of repacked straight dyes and 97,241 pounds of color mixtures.

Table 2 gives the distribution of the official samples examined by the various field stations. In addition, thousands of shipments were examined, hundreds of which involved a preliminary laboratory examination not reported in the table.

TABLE 2.—*Report of field stations for year ended June 30, 1919.*

Station.	Import samples.				Interstate samples.			Miscellaneous samples.	Total samples analyzed.	Hearings.	
	Legal.	Illegal.	Released without prejudice.	Floor inspection samples.	Legal.	Illegal.	Check analysis.			Personal.	By correspondence.
Central district:											
Chicago.....	140	52	39	212	214	504	159	2,819	3,888	50	380
Cincinnati..	64	1	0	20	121	294	16	261	757	0	259
Kansas City	0	0	0	0	3	23	0	23	41	1	83
Minneapolis	55	23	0	68	50	135	36	450	749	19	65
New Orleans.	15	18	0	59	24	66	39	896	1,052	51	202
St. Louis...	9	28	0	14	87	281	35	738	1,181	85	226
Total.....	**283**	**122**	**39**	**373**	**499**	**1,303**	**285**	**5,187**	**7,668**	**206**	**1,215**
Eastern district:											
Baltimore..	70	10	0	0	129	350	5	723	1,287	3	157
Boston.....	142	102	0	3,586	38	149	6	390	827	89	85
Buffalo.....	140	287	0	289	57	75	0	213	772	221	81
New York..	2,538	1,329	94	5,801	252	527	21	1,996	6,757	394	784
Philadelphia	73	31	0	454	46	171	2	193	509	27	94
Porto Rico .	201	422	9	554	0	10	0	132	674	415	8
Savannah..	65	3	5	1	101	252	8	381	826	11	117
Total.....	**3,229**	**2,184**	**108**	**10,685**	**623**	**1,534**	**42**	**4,028**	**11,652**	**1,160**	**1,326**
Western district:											
Denver.....	3	13	0	84	37	91	4	486	634	3	27
San Francisco.	177	297	9	9,760	49	150	23	1,995	2,700	297	90
Seattle.....	136	237	6	6,260	48	89	13	1,211	1,750	194	61
Total.....	**316**	**547**	**15**	**16,104**	**134**	**330**	**40**	**3,692**	**5,084**	**494**	**178**
Grand total....	**3,828**	**2,853**	**162**	**27,162**	**1,256**	**3,167**	**367**	**12,907**	**24,404**	**1,860**	**2,719**

A great deal of assistance has been given the Post Office Department in connection with the exclusion from the mails of patent medicines, alleged therapeutic devices, and similar materials, involving work on the part of the bureau very similar, so far as laboratory operations are concerned, to that carried on in the enforcement of the Food and Drugs Act.

IMPORTED FOODS AND DRUGS.

During the fall of 1918, and particularly the three or four months following the signing of the armistice, owing in part to embargoes and to the restriction of imports by the War Trade Board, imports were rather less in volume than at any other previous period. This was more noticeable in the case of food products than in the case of crude drugs, which have been less restricted and have been shipped from original sources to a greater extent than formerly. Disorganization of trade and of shipping, giving rise to delays, has caused many shipments to arrive in a more or less moldy condition. As a result of this disorganization, goods have been shipped before they were properly cleaned, particularly fennel, anise, cumin, caraway, fenugreek, and ajowan seeds, and thyme, savory, sage, and marjoram leaves, which in most instances have been released after proper cleaning. Goods in part moldy have been released after proper sorting and conditioning when this was practicable. A number of shipments of gum karaya, a product recently imported in large quantities, have been released after proper cleaning to remove excess bark or dirt. A chemical method was developed this year for the examination of this gum after grinding and conditioning. Not a few shipments of anise seed have been detained because they were mixed with an appreciable percentage of exhausted seed. In a few instances the poisonous leaves of *Coriaria myrtifolia* have been found in marjoram leaves. Substitution of crude drugs for others better known or for official species has not been uncommon. The following may be noted: Japanese aconite (*Aconitum fischeri* Reich.) for aconite (*Aconitum napellus* L.; red Jamaica or native Jamaica sarsaparilla (*Smilax utilis* Hensley) and the common brake (*Pteris aquilina* L.) for sarsaparilla; *Inula* species and an unidentified product from Mexico for arnica flowers (*Arnica montana* L.); Mexican orizaba root (*Ipomoea orizabensis* Leden.) for jalap (*Exogonium purga* Benth.) and for scammony (*Convolvulus scammonia* L.); Asiatic licorice (*Glycyrrhiza uralensis* Fisch.) for licorice; *Ballota hirsuta* Benth. for horehound (*Marrubium vulgare* L.); Egyptian henbane (*Hyoscyamus muticus* L.) for henbane (*Hyoscyamus niger* L.); *Arum maculatum* L. for *Colchicum autumnale* L.; Egyptian stramonium (*Datura metel* L.) for stramonium (*Datura stramonium* L.); *Ionidium* species for ipecac (*Cephaelis ipecacuanha* Rich.). Maracaibo bark was invoiced as cinchona bark, Peruvian bark, and cascarilla bark.

In other instances official drugs, such as aconite, belladonna, calisaya bark, and hyoscyamus, have been found deficient in alkaloid or active principle. In the case of substitutes or drugs deficient in active principle which may have some legitimate use, the bureau has felt that release on relabeling alone would not effectively prevent the goods from filtering into the channels of trade and being sold ulti-

mately as the official product. A public statement through the service and regulatory announcements has therefore been made that release in such cases will be conditioned not only on proper relabeling but also on definite information that the goods will be manufactured by a specified firm into products for which their use is approved.

Special attention has been given to medicinal preparations bearing statements of therapeutic or curative effect. The printed matter used with each preparation has been carefully reviewed by the bureau's medical staff in Washington, with a view to exhibiting a uniform and consistent attitude toward all such products. Copies of the comments made, with information regarding the labeling, have been transmitted on cards to all the port stations, thereby insuring perfectly uniform action. A distinction has been made between products intended for sale to the general public and those intended for physicians' use which are so labeled as not to affect the general public, properly confining all statements as to therapeutic use to an inclosed circular, leaving the outside label entirely free from such statements.

During 1918 many shipments of dried-egg products, yolk and albumen, coming from China, were found to contain notable quantities of zinc or zinc compounds. Such contamination occurred because these products were dried in zinc or zinc-lined trays, or, in some instances, in large plants, on zinc belts. During 1919 the shipments of yolk, some of them representing large lots manufactured by the spray process, have been found practically free from zinc. In the early part of the year several shipments of albumen were detained because of the presence of zinc, but during the latter part of the year a number of shipments, mostly small in amount but from a number of different manufacturers, have been found satisfactory. This would indicate that several firms in China have so changed their methods of manufacture that they can supply goods free from zinc, and will shortly be able to meet the demand for dried egg albumen and yolk, used in increasing quantities by bakers and manufacturers of bakers' supplies.

The last few months of the year saw the beginning of the resumption of normal trade in foods, notably olive oil, which had been subject to embargo in most countries. Large quantities, almost sufficient for normal demand, have come from Spain, and have caused the price to drop to nearly normal figures. In the past, Spain has furnished directly comparatively little olive oil to this country. The bureau's inspection has shown no instances of adulteration. The first few shipments have also been received of those particular foodstuffs from England, France, and Italy, that normally are imported in large quantities, but which ceased to come in during the last two years of the war. The first shipment of Smyrna figs received since the war began arrived during the last month of the year.

SUGARS, SUGAR DERIVATIVES, SIRUP.

Processes for the preparation of the sugar xylose, of gum industrially valuable as an adhesive, and of other useful substances from corncobs have been patented and made available to the public. Development work now being performed upon these processes offers a

prospect that in time a new industry utilizing corncobs, a by-product heretofore largely wasted, may be established. As such an industry would make xylose available in large quantities, studies on the utilization of this hitherto rare sugar have been undertaken. A relatively simple process for its conversion into gulonic lactone, which might be useful commercially, has been patented and published. Moreover, a large series of bacteria has been found capable of fermenting xylose, to form certain products which may be of value industrially.

Data on the occurrence of the rare sugar melezitose in a manna from the Douglas fir and on the crystallography and optical properties of three aldopentoses have been published. Papers upon the crystallographic properties of melezitose, upon the amide of α-*d*-mannoheptonic acid, and upon the rotatory powers of the amides of several α-hydroxy acids of the sugar group are in press.

The distribution of pure sugars, especially for use in bacteriological research, was more extensive this year than heretofore, varying amounts of 19 different pure sugars having been sent out.

The curtailment of distilling and brewing together with the war-time restrictions placed upon the consumption of sugar, seems to have stimulated the production of barley sugar or maltose, as well as that of maltose sirup. Since the extension of the uses of such material is a matter of some interest to the producer of barley, practical studies on the use of maltose sirup in candy manufacture have been undertaken. Preliminary results indicate that perhaps large quantities of maltose sirup can be employed in this way.

The project on the production of a uniform cane sirup that will neither ferment nor crystallize, which had reached such a stage that the problem was in the main how to introduce and cause to be used the processes devised in the bureau, has received a setback because yeast, necessary in these processes, is now obtainable only with difficulty. A search for substitutes for yeast has therefore been made, and preliminary results justify the hope that certain molds which can be grown easily and cheaply may form sufficient of the enzyme invertase to make it possible to use them instead of yeast for this particular purpose.

The bureau has cooperated with the Louisiana State Experiment Station in the study of the deterioration of raw sugars caused by the action of molds. In the preparation of cellulose acetates and their study, undertaken for the Bureau of Aircraft Production, some new cellulose compounds were prepared. This work has been closed.

FATS AND OILS.

Department Bulletin 769, "The Production and Conservation of Fats and Oils in the United States," giving a digest of the data collected during 1917 and 1918 by the U. S. Food Administration and the Bureau of Chemistry, was issued. This is perhaps the first complete and critical survey of the fat and oil industry and traffic of any country, and as a consequence the demand for the bulletin has been very great. A supplement containing the revised statistics up to January, 1919, is now in press. Hereafter the Bureau of the Census will collect the production, importation, and exportation figures on fats and oils, and issue them in quarterly reports.

The examination of tomato-seed oil has been completed, and the data thus secured submitted for publication.

A survey of the industrial recovery of wool grease has demonstrated clearly the necessity for a systematic investigation, to the end that less of this valuable material be wasted in the process of scouring wool.

CHEMISTRY AND NUTRITIVE VALUE OF PROTEINS.

The physico-chemical examination of gelatin has led to the publication of two articles entitled, respectively, "The Mutarotation of Gelatin and Its Significance in Gelation" and "The Effect of Hydrogen Ion Concentration on the Liquefaction of Gelatin," and to the preparation of a third, entitled "Determination of the Jellying Power of Gelatins and Glues by the Polariscope," which proposes a method for testing gelatins and glues based upon changes in rotatory power.

The basic amino acid, lysin, which is believed to be an essential ingredient of diets capable of supporting growth, was discoverd in hordein, the principal protein of barley.

A summary of the work on the proteins of the peanut and a preliminary announcement of the value of peanut flour in wheat bread has been presented. A loaf made from wheat flour with a small admixture of peanut flour and salts furnishes a diet that is biologically complete, is properly utilized by animals, and maintains normal growth. Even smaller amounts of soy-bean meal will give similar results.

The hydrolysis of stizolobin, the globulin of the Chinese velvet bean, *Stizolobium niveum*, has been completed. Two and one-half per cent of hydroxyglutaminic acid and from 9 to 10 per cent of aspartic acid were obtained from it. Rats fed upon a diet containing as the sole source of nitrogen the protein of the Georgia velvet bean grew normally to maturity. Further work is necessary to determine why the bean itself does not sustain growth. As has long been known, the globulin of the navy bean will not support normal growth. The bureau has discovered that if cystine be added to such a diet this protein will support growth. Moreover, normal growth can be obtained upon a diet containing navy beans to which cystine has been added. It also appears that the nutritive value of the globulin is somewhat improved by heating the protein in water. These observations are so suggestive that similar work upon other species of beans will be begun to determine if they, too, are deficient in cystine.

The data showing that coconut globulin contains all of the basic amino acids necessary to growth and that it, as well as crude coconut press cake, is capable of supporting growth, have been presented. It was subsequently found that mixtures of certain corn feeds with coconut press cake produce normal growth, which indicates that the coconut press cake contains sufficient water-soluble vitamine when the diet consists of equal amounts of the corn feed and the press cake. These findings justify the opinion expressed in the Report of the Chemist for 1918 that it is extremely desirable to retain in this country the copra-crushing industry which developed during the war.

SEA FOODS.

Bulletin 740, "A Study of Some of the Chemical Changes Which Occur in Oysters During Their Preparation for the Market," has been issued. It has been discovered that zinc, like copper, is invariably present in oysters, and probably in other mollusca. No relation could be traced between the zinc content of oysters and that of the waters from which they were taken. The data upon which these conclusions are based have been published. At the request of the Bureau of Fisheries a study was made of trade-waste effluents at Bridgeport, Conn., and West Point, Va., to determine the influence of such effluents upon the production of oysters in these localities.

Analyses have been made at various seasons of Pacific coast fishes, the food value of which is not known, and the results will be published when another season's work has been completed. Information on the preservation of Pacific coast sardines by smoking has been disseminated, and a publication on the preparation of salacchini will soon appear. The project to develop methods for the preservation of Pacific coast fish will be discontinued because funds are no longer available.

Bacteriological examination has shown that, as reported last year for Maine sardines, and published this year, the intestines of salmon and certain other fish that are not feeding are practically sterile. Evidently in the spoilage of such fish the bacterial invasion is from the skin inward, not from within the gut outward. Hence knowledge of the resistance offered by the skin of various kinds of fish to invasion by bacteria is of importance in determining the best methods of handling each species. Preliminary data indicate that the skin of different species varies appreciably in this respect. It follows, moreover, that in handling and transporting many kinds of fish it is of the utmost importance to avoid any injury or bruising of the skin.

The changes that take place in the flora of fish during shipment to market or cannery and during cold storage have also been studied, especially the microorganisms found on Pacific salmon. A related inquiry upon an aerobic spore-forming bacillus from canned salmon has been prepared for publication. In addition, search has been made for satisfactory chemical methods to detect spoilage of salmon, and to learn the conditions under which the fish may become stale in the cannery before being packed. While satisfactory progress has been made, at least another year will be required for the compeltion of the project.

A paper on the determination of the hexabromid and iodin values of the oil of salmon as a means of identifying the species in the canned product has been published.

Progress has been made in the study of the best methods of transporting fresh fish. Some shippers have been induced to substitute for barrels used as shipping containers 100-pound boxes, 30 inches long by 15 inches wide by 15 inches deep. In such boxes the lower layers of fish are not subjected to as much pressure and bruising as in barrels or when shipped loose with ice in the bottom of refrigerator cars. Study has shown that in barrels the pressure upon the lower layer of fish may be so great as to produce a shrinkage of over

8 per cent in five days, whereas the shrinkage in the top layer is practically negligible.

Studies have also been made on the chilling of fish to prevent their rise in temperature while being transported in warm climates to the refrigerator. The preservation of fish by freezing, and especially the freezing of fish in chilled brine, has been investigated. It was determined that in the latter process the brine penetrates through the skin for a short distance.

A large fund of information concerning the commercial handling of fish intended for freezer storage, and on the equipment of fish freezers has been obtained. It has thus been possible to give advice to operators and prospective builders of fish freezers. Many persons in the various branches of the fish industry were given information. Producers on the Maryland, Virginia, North Carolina, and Florida coasts were instructed in the packing of fish and loading of refrigerator cars. In cooperation with the Bureau of Fisheries, the bureau supervised the handling and freight transportation of fish in car lots from the producing section in Florida to Savannah, Ga., Louisville, Ky., Nashville, Tenn., and Indianapolis, Ind. Approximately 400,000 pounds of fish were transported in this way, and in consequence the market for Florida fish was greatly extended. Moreover, in cooperation with the Bureau of Fisheries, analyses of various kinds of salt were made to determine the characteristics of those most suitable for salting fish.

POULTRY AND EGGS.

The following publications have been issued: Department Bulletin 391, "Accuracy in Commercial Grading of Opened Eggs;" Department Bulletin 702, "Efficiency of Commercial Egg Candling;" Department Bulletin 775, "Commercial Preservation of Eggs by Cold Storage;" and Department Circular 25, "Points for Egg Buyers."

A material diminution in the breakage of eggs during transportation resulting from faulty loading and stowing of freight cars was brought about through cooperation with the Railroad Administration. Employees of the Railroad Administration were detailed to the Bureau of Chemistry, where they received instruction in proper methods of loading and stowing eggs in freight cars. Whenever cars were received at terminals with the loads in a badly damaged condition, these employees of the Railroad Administration paid personal visits to the shipper for the purpose of instructing him how properly to load cars and avoid more damage in future shipments.

DAIRY PRODUCTS.

Much attention has been given to the development of analytical and microscopical methods for distinguishing from fresh milk remade milk, produced by combining mechanically skim-milk powder, water, and butter fat. No wholly satisfactory microscopic method has been devised. Physico-chemical methods have been found successful only under certain conditions. Physiological analytical methods have also been successful under some conditions, but it still remains to be determined whether any of these methods or any combination of them will prove universally applicable.

An extensive investigation designed to furnish information for use in the enforcement of the Food and Drugs Act has been undertaken

to develop methods for the detection of spoilage in cream and butter. The flora of the various types of old cream, the products of the action of microorganisms that may be present in such cream, the effect of neutralizing and pasteurizing it before churning, the production of butter from it, and the possible occurrence of the products of the metabolism of microorganisms in the butter are being studied. This investigation is conducted mainly in the field, in cooperation with the creameries. As such work can be done in a satisfactory manner only during a portion of the year, it is probable that it will be necessary to continue it through several seasons.

BEVERAGES.

An article entitled "Composition and Food Value of Bottled Soft Drinks" was published in the Department Yearbook for 1918.

The work begun last year upon the substitution of other sweetening agents for sugar as a means of sugar conservation was continued. Three articles on the subject, published in the trade journals during 1918, were widely copied. Three other articles were added this year, "Refiners' Sirup for Bottlers," "Soft Drinks without Sugar," and "Substitute Sirups for Soft Drinks." With the cooperation of the United States Food Administration, many thousands of copies of a brief résumé of the subject were distributed, and the information given in person at meetings of the trade. A valuable service was thus rendered the soft-drink industry, and many bottlers who were unable to secure sugar were saved from disaster. Some of the substitutes proved to have such merit that they probably will remain in permanent use.

Studies have been conducted upon soda flavors and upon the flora of sweetened nonalcoholic beverages. An article has been prepared upon the longevity of bacteria in commercial bottled water.

CITRUS BY-PRODUCTS.

The citrus by-product project was organized on its present basis in 1914, the object being to develop first upon a laboratory, and later upon a commercial scale methods for the manufacture of salable products from citrus fruit not suitable for shipment as fresh fruit. Minor defects, such as small bruises or punctures from thorns, gravel, or rough boxes, destroy the shipping value of fruit, as such defects offer points for infection to various bacterial and fungous growths which cause decay. Fruit that is too small or too large, unsightly or misshapen, has also a doubtful shipping value. The amount of waste fruit averages from year to year about 3 per cent of the total crop.

The by-product laboratory at Los Angeles has been studying the utilization of cull oranges in making stable products. Marmalade, marmalade stock, juice, vinegar, and candied peel are possibilities in this direction. Methods for the production of all of these, except juice, have been developed, and either have been given to the public or are now ready for publication. Candied peel and juice of excellent quality can be made from grapefruit, and methods for their production have been devised and given to the industry.

The existing methods for the manufacture of citrate of lime and citric acid have been improved and adapted to California conditions.

They are now being used satisfactorily on a large commercial scale, and while there will always be unsolved problems, as in every chemical industry, the methods of manufacture of citric acid are sufficiently well developed to permit its manufacture from the raw product at a fair profit to the lemon grower.

When these investigations were begun there were but one or two struggling by-product companies in California, which were making no appreciable inroad into the enormous supply of cull fruit available. After a few years' work and the expenditure of less than $100,000 this situation has materially changed. Four stable, going concerns, three of them privately owned, and one a cooperative growers' company, are now manufacturing lemon by-products. The total annual manufacturing capacity of these plants is over 1,500,000 pounds of citric acid, over 500,000 pounds of citrate of lime, and over 50,000 pounds of lemon oil. Some 20 concerns may be said to be producing orange by-products on a considerable scale. The products consist largely of marmalade, about 50 per cent of which is produced by one cooperative company. Marmalade stock, jellies, and candied peel are also being made in smaller quantities. The total output of orange by-products for the present year will approximate 6,000,000 pounds. Proof of the advance which has been made since this project began is the increase in the price of cull fruit. Less than five years ago cull lemons could be had in large quantities at $5 a ton; to-day advertisements appear in several agricultural papers offering from $20 to $25 a ton for the same material, in face of the fact that a larger quantity is now available. The same situation exists in the case of oranges. In former years $5 would buy a ton of sound cull oranges; the price at the present time for sound culls is from $20 to $30 a ton.

The by-product laboratory has been in close touch with a great majority of the by-product manufacturers, advising them as to processes and assisting them in every possible way in establishing their business. No small amount of good has been accomplished in pointing out defects in proposed methods of operation, and much money and time has thus been saved investors and experimenters in this field.

Work upon the production of citrus by-products was also done in Florida during the year, and it is proposed next season to prosecute the Florida part of the project vigorously.

DEHYDRATION OF FRUITS AND VEGETABLES.

The special appropriation for dehydration did not become available till late in the fall, when the production of fruits and vegetables is small. The work that could be undertaken was therefore somewhat limited, and in consequence a considerable proportion of the funds available was not used. During the war a number of plants were constructed by private enterprise to dry fruits and vegetables for military purposes, but the majority of the products, while nutritious, were unattractive and inferior in quality. The bureau endeavored to investigate all the processes in use, in the hope of suggesting improvements whereby satisfactory dried fruits and vegetables might be produced, and a sound, permanent industry established. To this end all the larger plants were carefully inspected, and their processes studied under commercial conditions. Numerous conferences were held with

manufacturers, all of whom exhibited eagerness to cooperate and to offer every facility to promote the work. Laboratory investigations were undertaken to compare the nutritional qualities of dried products with those of canned and fresh material. About 30 departments of home economics, mostly in the agricultural colleges, cooperated, thus making it possible to reach conclusions more speedily than could have been done had the work been confined to a single laboratory. Studies on the nutritional value of dried products were also undertaken at Johns Hopkins University and at the University of Rochester. On the whole, the findings have been quite favorable.

Studies have also been made to determine the best conditions for the storage of dried products, especially the most suitable types of containers, and an investigation of the flora of such products is in progress. Bulletins bearing on the various phases of the dehydration work, now in preparation, should appear during the coming year. Two general addresses by those in charge of the work have been published, one of them as Office of the Secretary Circular 126, "Relation of Dehydration to Agriculture." The net result of the work has been of real practical assistance to the industry. Poor materials are disappearing from the market, and a few plants producing materials of excellent quality have become established.

In cooperation with a plant in South Carolina, an attempt was made by the bureau to produce sweet potato flour by the methods used with success in the production of white potato flour. The plant was operated for a few months, but the results were disappointing because of the very hygroscopic nature of the product which influenced unfavorably its keeping quality. The data will be published. The bureau has also been able to assist in the establishment of the white potato flour industry, which seems to be gaining ground. Data on potato flour and potato bread have been published.

Cooperation with the potato starch industry is in progress, looking toward the utilization of potato pomace, improvement of the methods for drying starch, the production of potato dextrin, and an increase in the capacity of the plants. Assistance was given to the Office of the Quartermaster General in the inspection and supervision of plants producing dehydrated vegetables for the Army.

FLOUR AND CEREALS.

Department Bulletin 701, "The Chemical Analysis of Wheat-Flour Substitutes and of the Breads Made Therefrom," has been issued, and a paper on the composition and baking value of the different sized particles of flour is in press.

As it was proposed during the year to import from Australia wheat badly infested with weevils, experiments were performed to determine the degree to which wheat may be heated in the attempt to destroy the weevils without affecting the quality of flour produced from the treated wheat. It was found safe to heat to 160° F., but not to 180° F., for 30 minutes.

Rice is one of the flour substitutes employed during the war which promises to continue to be used in baking. Baking experiments, therefore, were made with flour prepared from different varieties and grades of rice, polished to varying degrees. Fifteen per cent of rice and 85 per cent of white flour were used. No appreciable dif-

ferences were found in the baking qualities of such mixtures, irrespective of the fineness of the rice flour used. As was to be expected, the color of the bread was influenced by the degree to which the rice had been polished.

Much attention has been given to the study of the spoilage of corn meal, with a view to determining the most suitable conditions for its storage. The spoilage produced by different organisms and the effect of the growth of such organisms on the composition of the meal, especially with relation to acidity and rancidity, have been investigated, in the hope that a sound basis may be found to estimate the degree of spoilage of corn meal and its fitness for food.

GRAIN MILL, ELEVATOR, AND COTTON GIN EXPLOSIONS AND FIRES.

The emergency demonstration campaign, conducted in cooperation with the Bureau of Markets, to conserve grain and flour by preventing explosions and fires was carried out in the manner described in the Report of the Chemist for 1918. Five thousand six hundred plants were visited and over 30,000 pledge cards signed by the owners, operators, and employees. A number of recommendations suggested to the companies as possible precautions against dust explosions were cheerfully adopted, and it is believed that these slight changes have assisted in reducing the loss in this country due to explosions and fires in mills and elevators. Not a serious explosion occurred in such a plant during the year. A very disastrous explosion did occur in a different type of plant, a starch works, 43 persons being killed and a number injured. This demonstrates clearly that the work should be extended to other dusty industries. As no funds were available to proceed with the work after the close of the fiscal year, and as the U. S. Grain Corporation desired that it be continued as a form of insurance for its own operations, arrangements were made to transfer the force engaged upon this campaign to the rolls of the Grain Corporation. The work will be continued by that corporation, the Bureau of Chemistry collaborating by furnishing general supervision.

The campaign to prevent explosions and fires in thrashing machines has been continued and extended to cover other sections than Oregon, Idaho, and Washington, to which it had hitherto been limited. In cooperation with the Bureau of Plant Industry and the Bureau of Markets, special attention was given to the development of the suction-fan installation to remove dust from thrashing machines, and an effort was made to determine the effect of its operation on grain cleaning and on the possibility of smut-spore collection and disposal in order to prevent the dissemination of the spores over surrounding land. Plant pathologists have expressed themselves as quite hopeful that the devices for the disposal of spores which have been designed and tested may prove of great service in the control of the smut of wheat.

The discovery that many of the fires in the cotton gins of the Southwest are due to static electricity reported last year was confirmed this year. The limited funds available made it necessary to confine this work, which was done in cooperation with the Bureau of Markets and the various State and insurance agencies, almost en-

tirely to the State of Texas. Department Circular 28, "Cotton Gin Fires," issued during the year, was distributed among cotton ginners, insurance agencies, and others interested throughout the South. Though still unfinished, the work was closed at the end of the fiscal year, no appropriations being available thereafter.

DRUGS AND PHARMACOLOGY.

A series of researches upon crude drugs have been published under the following titles: "Commercial Viburnum Barks and Preparations;" "Karaya Gum, a Substitute for Tragacanth;" "*Ballota hirsuta* Benth., an Adulterant of Horehound (*Marrubium vulgare* L.);" "Piptostegia Root, *Piptostegia Pisonis* Mart, so-called Brazilian Jalap;" "Botanicals of the Blue Ridge;" "*Conium maculatum* L., and *Aethusa cynapium* L., an Adulterant;" and "So-called Syrian Alkanet, *Macrotomia cephalotes*, D. C." Manuscripts have been submitted for publication under the titles: "*Santolina chaemacyparissus* L., an Adulterant of *Matricaria chamomilla* L.;" "The Structure of Bermuda Grass Compared with that of Triticum;" and "Some Effects of the War upon Crude Drug Importations."

Evidence has been obtained that the part of ipecac which is often referred to as "stems" consists largely of the underground part of the axis, more properly referred to as rhizome. The young and smooth roots at times may also be considered as stem, since they resemble the rhizome rather closely in appearance. These parts, evidently referred to by mistake as stem, were found to contain appreciable quantities of ether-soluble alkaloids. It appears quite probable that the problem concerned with the utilization of this now rejected but valuable part of the ipecac plant can be solved by modifying the definition for ipecac to read: "The dried roots and rhizomes * * *."

The optical crystallographic properties of the cinchona alkaloids have been determined, so that a new method for their identification, even when present in small amounts if they can be obtained in crystalline form, is now available. An inquiry into the occurrence of lead in pharmaceutical zinc oxid has been published. A paper upon the preparation of sodium-p-hydroxyphenyl-arsenate, an intermediate in the manufacture of arsphenamine, and one entitled "A Review of the American Patent Literature on Arsphenamine (Salvarsan) and Other Arsenicals" have been issued.

A new method for determining the toxic effect of various agents administered over long periods of time in small dosage has proved of service. Young rats are placed upon such a standard, adequate diet as has been introduced by Osborne and Mendel and by McCollum. To the diet the substance under investigation is added, and the growth curve of the young animals plotted. Disturbances of health usually become evident when such growth curves are compared with those of normal animals. It is hoped that by this method it may be possible to determine the lower limit of toxicity of many substances. Such an investigation upon cadmium, which during the war it was proposed to substitute in part for tin in solder and other alloys, has been completed.

An extensive study on the toxic action of gossypol, a phenol found in cotton seed, to which the poisonous action of some cottonseed meal

has been attributed, is in progress. Complete information on this subject is necessary, in view of the recommendations now being made by various dietitians that cottonseed meal be used as food for man. The optical crystallographic properties of gossypol have been determined.

The description of a transparent celluloid renal oncometer or plethysmograph has been published.

The services of the bureau's experts were furnished the scientific division of the Shipping Board and the Tariff Commission, in connection with the consideration of drug and chemical products.

PLANT CHEMISTRY.

Seeds of about 40 individual plants of the mustards, *Brassica cernua* and *Brassica juncea*, grown in Illinois, have been examined separately for essential oil. In general, the volatile oil content of these seeds was much above the average, reaching in some cases 1.5 per cent. Seeds of the varieties from which the largest yields of oil were obtained have been planted at Arlington, Va., for further study. Under the title "Capsaicin, the Pungent Principle of Capsicum," the results of the study of the constitution of the pungent principle of red pepper have been published. It has been possible to produce synthetically a series of substances of marked pungency.

A report on the results of a survey on the caffeine content of the North American species of the genus Ilex, under the title "*Ilex vomitoria* as a Native Source of Caffeine," is in press. Of the various species examined, only *Ilex vomitoria*, used since prehistoric times by the Indians for the preparation of a beverage, was found to contain caffeine.

Department Bulletin 773, "Chemical Analyses of Logan Blackberry (Loganberry) Juices," has been issued.

To further the educational campaign to improve conditions in the production of tomato products, which has been conducted for some years, a paper on "Factory Investigations on the Manufacture of Tomato Pulp and Paste" was printed in a trade journal.

Articles upon the determination of the distribution of nitrogen in certain seeds, upon the reduction of nitrates by seedlings, and upon the effect of lime upon the alkali tolerance of wheat seedlings have been published. Studies of pumpkin and squash seed have been completed.

At the request of the Bureau of Plant Industry, the acidity of the soil under certain special conditions was investigated.

For the Bureau of Biological Survey many samples of water from North Dakota lakes were examined to obtain information regarding the propagation of aquatic plants.

In cooperation with the Bureau of Markets, an extensive survey is being made on the composition of cotton seed from various sections of the country. In addition to the analyses made in the bureau, 60,000 analyses have been obtained from 27 other laboratories, and arrangements to obtain from these laboratories similar analyses of the 1918 crop have been completed. Studies begun some years ago to determine whether the oil content of a given sample of seed could be estimated from the density of the seed, or the weight per thousand, and the like, factors of worth in the evaluation of barley, have not yielded results of value.

FOOD FLORA, SPOILAGE, AND FERMENTATION.

References to the year's work upon the spoilage and the flora of specific articles of food are made elsewhere in this report, where such foodstuffs are specifically considered. The general investigations upon poisoning by spoiled food have been continued, and some of the results embodied in two papers entitled, respectively, "Toxin Formation by a Variety of *B. botulinus* when Cultivated Aerobically under Various Conditions: Its Possible Production in the Animal Body," and "Botulism from Canned Asparagus." In general, the results indicate that the strain of *Bacillus botulinus* isolated from the spoiled asparagus which produced fatal poisoning is capable of withstanding the temperature used in the processing of canned goods by methods in vogue for home canning or for commercial canning, that the organism produces putrefactive decomposition, and that the principal safeguard against poisoning from such types of organisms as this lies in the scrupulous examination of every can of material to make sure that no spoiled food is included in the portions eaten.

The study of the molds used in the oriental fermentation industries has included several lines of experimentation. Soy sauce has been made according to the methods employed in Japan. Enzymic studies have been performed with a bran koji made with *Aspergillus Wentii* and various strains of *Aspergillus flavus*. The metabolism of this group of organisms has been studied, especially the chemical changes they produce in soy fermentation, and the formation of phenolic substances. A study of Chinese red rice as produced by the growth of *Monascus purpureus* has been prepared for publication under the title of "Laboratory Experiments on the Manufacture of Chinese Ang-khak in the United States."

In connection with the studies to improve the manufacture of pickles and prevent the losses that occur at present because of the softening of the pickles during storage, arrangements have been made with the Bureau of Plant Industry and with the Mississippi Agricultural College to study the fermentable sugar content of different varieties of cucumbers. Cooperation has also been maintained with manufacturers of sauerkraut, with a view to controlling the temperature of the kraut as it goes into the fermenting vat, in order to obtain more nearly the optimum conditions of fermentation than has hitherto been the case. A report on the use of pure culture starters in the preparation of sauerkraut has been issued. The work on the preservation of foods by fermentation and brining has been continued, and the information of value thus obtained has been transmitted to the States Relations Service for demonstration in the field. A report of the work is in manuscript form. A paper entitled "A Preliminary Report upon Some Halophilic Bacteria" has been printed.

The requests for cultures from the bureau's extensive and growing collection have been numerous, centering, in recent years, upon the citric-acid-forming group of molds, the cheese-ripening fungi, and those connected with the oriental fermentation industries. Many routine identifications of cultures were made for various investigators.

A communication was made upon the chemical analyses of bacteriological bouillons.

INSECTICIDES AND FUNGICIDES.

Department Bulletin 750, "A Method for Preparing a Commercial Grade of Calcium Arsenate," and a communication on plants used as insecticides, have been printed, while a paper describing the diagnostic characters of the field daisy, used as an adulterant of pyrethrum, is in press. Equipment to produce insecticides and fungicides on a semicommercial scale has been secured, to the end that ways and means to improve manufacturing processes and to devise new types of useful insecticides and fungicides may be investigated. In cooperation with the Bureau of Entomology, the possible value of war gases as insecticides has been taken up. Phosgen and cyanogen chlorid have been studied. The field men of the Bureau of Entomology have been assisted in the work of controlling the boll weevil.

CONTAINERS.

The bureau was invited to designate a representative to serve upon the Committee on Standard Specifications for Kitchen Ware, Mess Equipment, and Flat Ware for the Army. This led to the examination of 61 samples of enamel ware from 26 different American manufacturers. The test most frequently used was made by boiling 500 cubic centimeters of 4 per cent acetic acid, the strength of standard vinegar, in the vessel for half an hour. No antimony was dissolved from 17 samples obtained from 9 manufacturers. Thirty-four vessels, both white and gray ware, yielded to the solution from 0.5 to 2.0 milligrams of antimony. Lead was found in ware from only one manufacturer. Earthenware was then examined, and in some instances its glaze was found to yield to the acetic acid solution small amounts of lead.

Analyses have been made for the War Department and the War Industries Board of foil used to wrap food products and other materials. Some foil is pure aluminum, some is pure tin, while some contains lead and tin, with the tin varying from 1 to 30 per cent. Some of the composite foils appear to be alloys, while others consist of an inner layer of lead covered by two layers of tin. In most of the instances when foil containing lead is used a waxed paper wrapping is placed between the metal and the food product.

Except in the case of phosphorus matches, there are no Federal laws to protect the public against the presence of poisonous substances in articles of common use in the household. Many foreign countries have long had such legislation on their statute books.

Cooperation with the industry to ascertain what types of tin plate are most suitable for food containers has been continued. Special attention is being given to the best means of preventing the perforation of cans containing acid fruits. The results of the successful trial in a tin mill under ordinary conditions of hydrogenated oils in place of palm oil have been prepared for publication.

A paper dealing with the use of the impact tester for fiber board has been presented, and work was continued on the improvement of the water-resisting properties of fiber board for fiber containers, both by substituting other adhesives for silicate of soda and by using external treatments which will not interfere with the future use of the stock. A report on the various kinds of water-resistant baling papers was given.

COLOR INVESTIGATIONS.

The general plan of the color investigations which have been in progress in the bureau for but a few years was first fully discussed in the Report of the Chemist last year. This year it is possible to report specific results.

Work upon photosensitizing dyes was begun at the instigation of the War Department. The three important sensitizing dyes, pinacyanol, pinaverdol, and dicyanin, have been prepared and made available. Preparations of these dyes have been distributed to those requiring them, including photographic plate manufacturers and astrophysicists, who have reported them satisfactory. A new dye showing absorption further in the infra-red part of the spectrum than any other known dye has been prepared. It may prove of great value to physicists. New processes for the manufacture of these photosensitizing dyes have been discovered and patent applications filed. Four papers upon the chemical properties of and the methods for producing these dyes and their intermediates and one upon their crystallographic and optical constants have been published. As it is now possible to establish in the United States this very small but scientifically extremely important branch of the dye industry, steps to bring this about are being taken.

The new method developed in the bureau for the production of phthalic anhydrid by catalytic air oxidation is in successful commercial use, and cooperation was begun with another manufacturer during the year. Certain theoretical laboratory investigations remain to be completed before a final report of the whole investigation can be published.

From cymene a new photographic developer has been produced and the process published. Studies upon the chlorination of cymene are in progress. A report upon the preparation of 2-chlor-5-6-dinitrocymene is ready for the printer.

The sulphonation studies have progressed to such a point that cooperation with the industry upon the sulphonation of benzene has begun. Observations of great interest, especially on the sulphonation of naphthalene, are in process of investigation. Reports have been prepared upon "Some Difficultly Soluble Salts of Certain Naphthalene Sulphonic Acids," and upon "A Method for the Qualitative Determination of Some of the Naphthalene Sulphonic Acids."

The laboratory and plant studies on the production of isopropyl alcohol and its oxidation to acetone, undertaken for the Bureau of Aircraft Production, have been completed. It seems probable that the process will prove of commercial value.

Papers have also been presented upon the following subjects: "Some Aspects of the Behavior of Charcoal with Respect to Chlorin;" "A Method for the Purification of Certain Azo Dyes;" and "The Catalysis of Some Vapor Phase Oxidation Reactions."

The laboratory under construction at Arlington for large-scale or semi-industrial operations, which was loaned to the Nitrate Division of the Bureau of Ordnance during the war, has been released to the Bureau of Chemistry and should be ready for occupancy during the coming year.

LEATHER AND TANNING.

Farmers' Bulletin 1055, "Country Hides and Skins," has been prepared in cooperation with the Bureau of Animal Industry and Bureau of Markets. Plans have been made to disseminate the information contained in this bulletin widely through the county agents of the States Relations Service, the distribution of posters, and the like, in the hope that the very great waste of valuable raw materials that now occurs because of lack of knowledge may be stopped. Papers on the waterproofing of leather, on the relative absorption of oils and greases by wet and dry leather, on the testing of materials for increasing water resistance of sole leather, and on the suitability of various solvents for the extraction of oils and greases from leather were presented at various meetings of technical societies. A farmers' bulletin on the care of shoes and harness is in preparation. Assistance has been rendered the War Department and the War Industries Board in regard to the waterproofing of leather and the preparation of specifications for various kinds of leather, the Post Office Department on specifications for bag leather, and the U. S. Shipping Board. Methods for the tanning of alligator skins have been furnished the Indian Commission of the Interior Department, which contemplates the establishment of the industry among the Indians of Florida.

NAVAL STORES.

The final report on the production of naval stores, including gum rosin and gum turpentine, wood rosin and wood turpentine, and rosin reclaimed from batting dross, has been published, and put into the hands of producers, factors, dealers, and consumers of naval stores. This report shows the total production for the last season, stocks on hand at stills on March 1, 1919, and total shipments from stills during the period from April 1, 1918, to March 1, 1919. Reports have also been made of the stocks of rosin and turpentine in the hands of the consumers of naval stores and of the stocks in the storage yards at the principal points of distribution in the country. Assistance was given the Bureau of the Census in the preparation of the schedule for naval-stores statistics and of the lists of naval-stores producers.

Specifications on the properties, the sampling, and the laboratory examination of turpentine have been prepared and submitted to the Interdepartmental Committee on Paint Specifications for Government Bureaus. Much investigational work was required in this connection, because fresh virgin turpentine may not reach the minimum limits formerly set for specific gravity and refractive index, while turpentine taken from storage tanks in the South which have remained partly filled for a year or more may exceed the limits previously set for these constants.

In accordance with the practice of the past to place glass types for grading rosin at convenient points, a set of types has been deposited on loan with the secretary of the Chamber of Commerce of Cleveland, Ohio, for the use of consumers and dealers in that vicinity.

PAPER AND FABRICS.

Assistance in the preparation of specifications for paper has been given to the congressional Joint Committee on Printing, to the Post Office Department, and to the Treasury Department.

The study of the waterproofing, mildewproofing, and fireproofing of fabrics for farm use has been continued. A farmers' bulletin on waterproofing and mildewproofing for farm purposes, as well as an article on the general toxicity of soaps of heavy metals, alone and in combination, to fungi occurring on textiles, are in preparation. A paper entitled "Water Resistance of Fabrics" is in press.

Assistance has been given to the Office of the Quartermaster General and to the Chief of Staff of the Army on the preservative treatment of fabrics and on the repairing and waterproofing of tentage.

METHODS AND APPARATUS.

Methods have been published for the estimation of theobromin, of potassium guaiacol sulphonate, of citral, of mercury precipitated as mercuric zinc thiocyanate, of zinc precipitated as zinc mercury thiocyanate, of copper in insecticides, of zinc and copper in gelatin, of tyrosine in proteins, of the loosely bound nitrogen in eggs as ammonia, of the lower alkylamines in the presence of ammonia, of coumarin in factitious vanilla extracts, of iodin in mineral waters and brine, and of the acidity of grain extracts. Report has been made upon the use of benzaldehyde sulphite compound as a standard in the quantitative separation and estimation of benzaldehyde and benzoic acid, upon a method for the rapid analysis of mixtures of chlorinated toluene, and upon the use of thymosulphophthalein as an indicator in acidimetric titrations.

Methods are in process of publication upon the determination of bromid in mineral waters and brines, the estimation of monobromated camphor in migraine tablets, the use of kaolin in tannin analysis, the determination of water solubles in leather, the determination of caffeine, and the determination of the water resistance of fabrics. Certain other investigations upon analytical methods are referred to elsewhere in this report.

Descriptions of laboratory apparatus for rapid evaporation, and of a new type of volumenometer have been published.

The bureau's machinery for the examination of supplies purchased has been reorganized, and a paper on the general subject of laboratory apparatus was presented to the American Chemical Society.

ANALYTICAL WORK FOR OTHER DEPARTMENTS.

For other executive departments and Government establishments, 17,392 samples were analyzed. This is a larger number than normal, due to the fact that the various war agencies called upon the bureau for much analytical work in the purchase of war materials, particularly food, drugs, and leather. While it is not probable that the number of samples analyzed for other departments and war agencies will be as large in subsequent years, the indications are that it will be noticeably larger than before the war, since many of the Government agencies have found that a chemical test of materials purchased

aided them in determining and controlling the quality of such materials, and they will avail themselves of this service in time of peace as well as in time of war.

In addition to the samples analyzed for the various departments, as shown in Table 3, the bureau conducted extensive investigational work on a number of problems for the various governmental agencies.

TABLE 3.—*Samples analyzed for other departments.*

Department.	Number of samples.	Department.	Number of samples.
Department of State	4	District of Columbia	14
Department of the Treasury	319	Council of National Defense	25
Department of War	9,310	Shipping Board	7
Department of Justice	411	Smithsonian Institution	1
Post Office Department	96	General Supply Committee	5
Department of the Navy	1,184	Allied purchasing boards	8,993
Department of the Interior	26	War Trade Board	10
Department of Commerce	193	Emergency Fleet Corporation	2
Food Administration	161		
Government Printing Office	1	Total	20,868
The Panama Canal	106		

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